

## Nuclear Reactions

A **chemical** reaction involves the rearrangement of electrons. A **nuclear** reaction involves the rearrangement of protons and neutrons

- When nuclear reactions occur, a huge amount of energy is released in the form of radiation & reactions cannot be stopped
- All elements heavier than bismuth can decay into lighter elements & some lighter ones can decay

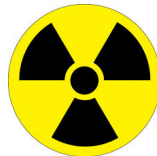
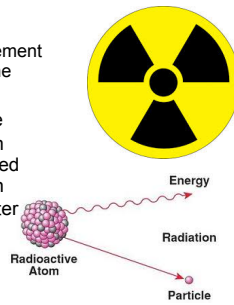
### Simple Nuclear Reaction Examples

#### Nuclear Decay

- Alpha Decay
  - Beta Decay
  - Gamma Radiation
- Nuclear Fission  
Nuclear Fusion

### Writing Equations for Nuclear Reactions

The sum of the mass numbers must balance  
The sum of the atomic numbers must balance



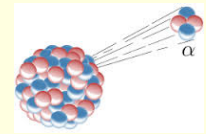
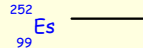
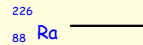
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## Alpha Decay: ( $\alpha$ )

An atom breaks down by ejecting an alpha particle

An alpha particle is a He nucleus  ${}_2^4\text{He}$ . It contains  $2p^+$  and  $2n^0$

Example:

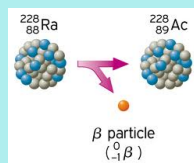
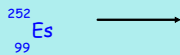
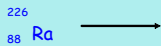


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## Beta Decay: ( $\beta$ )

An atom breaks down by ejecting a beta particle ( ${}_{-1}^0e$ ). Which is either a high energy electron or a positron ( ${}_{+1}^0e$ )

Example:



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## Gamma Radiation: ( $\gamma$ )

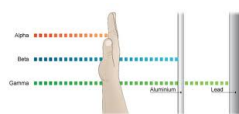
Accompanies most nuclear reactions as the atoms in the excited state relax and emit large amounts of energy ( ${}_{0}^0\gamma$ ). While there is a large energy release, the beginning element is not altered.

Example: Cesium-137 undergoes beta decay and releases gamma radiation

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## Radiation Comparison

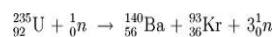
- In terms of energy released, gamma is stronger than beta which is stronger than alpha
- A few inches of lead is required to stop high energy gamma radiation
- Alpha & beta decay involve the changing of an element into a new element and this is called transmutation. Transmutation does not occur with gamma radiation



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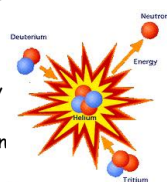
## Nuclear Fission

A larger atom is broken into two smaller atoms with energy released. Usually involves the firing of a neutron at the nucleus of a heavy atom; the atom splits and neutrons are released.



## Nuclear Fusion

- Involves 2 or more smaller atoms joining (fusing) together to form one larger atom with enormous amounts of energy
- The end products are usually light stable nuclei whereas the products of nuclear fission are heavy & unstable
- A lot of energy must be provided at the beginning to get the reaction started



<http://world.time.com/2013/08/19/more-than-two-years-after-meltdown-doubt-and-fear-remain-over-fukushimas-safety/>

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